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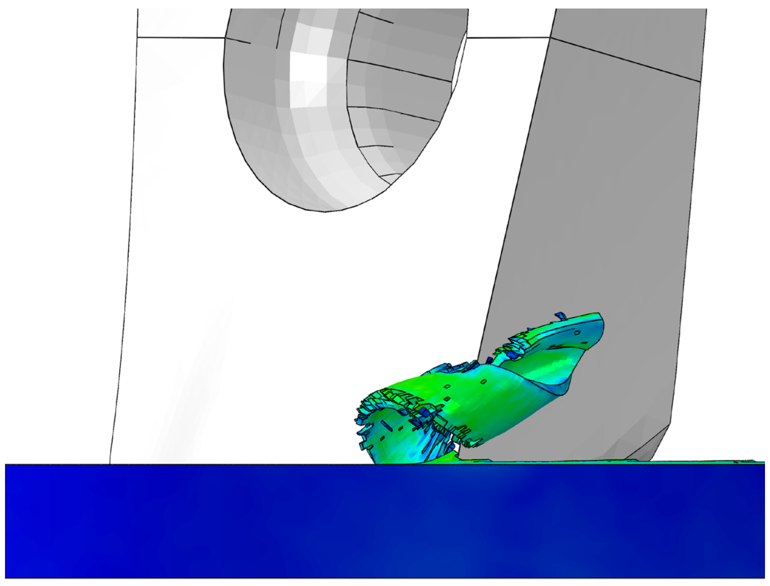
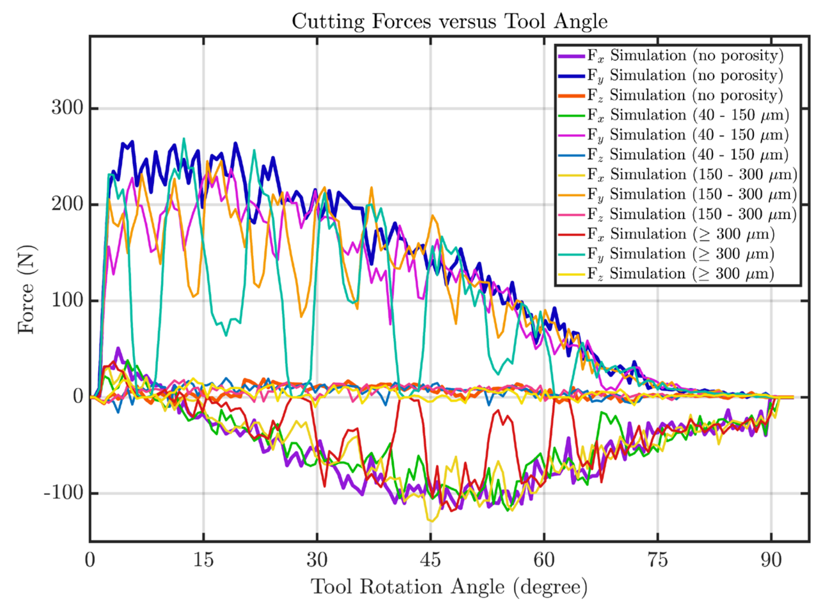
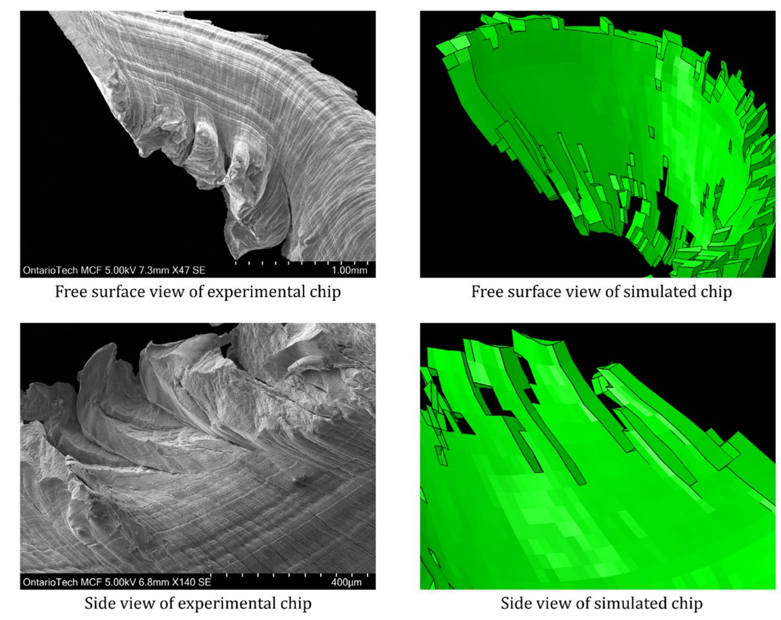
Finite element analysis of milling AM AlSi10Mg with porosity defects







Overview

- A novel three-dimensional finite element analysis to model the milling of additively manufactured AlSi10Mg alloy.
- The chip formation is simulated in addition to numerically predicting the cutting forces involved.
- A validated numerical model eliminates the need to perform expensive experimentation.

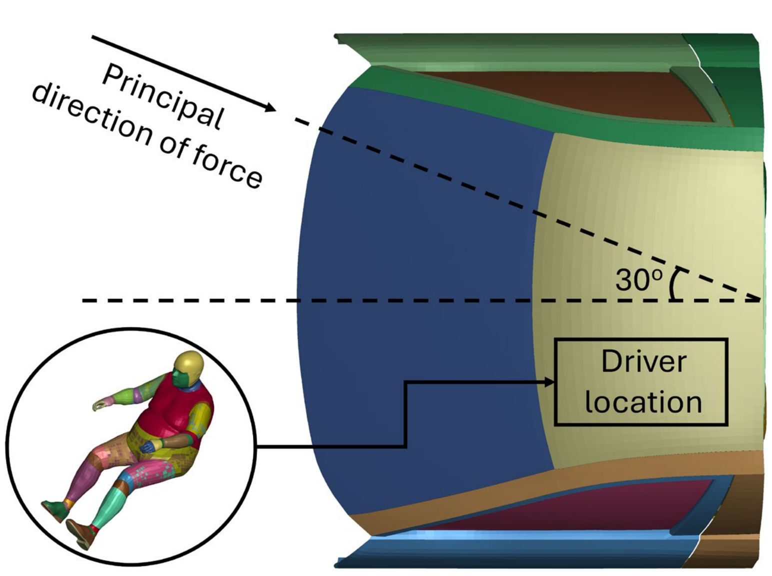
Approach

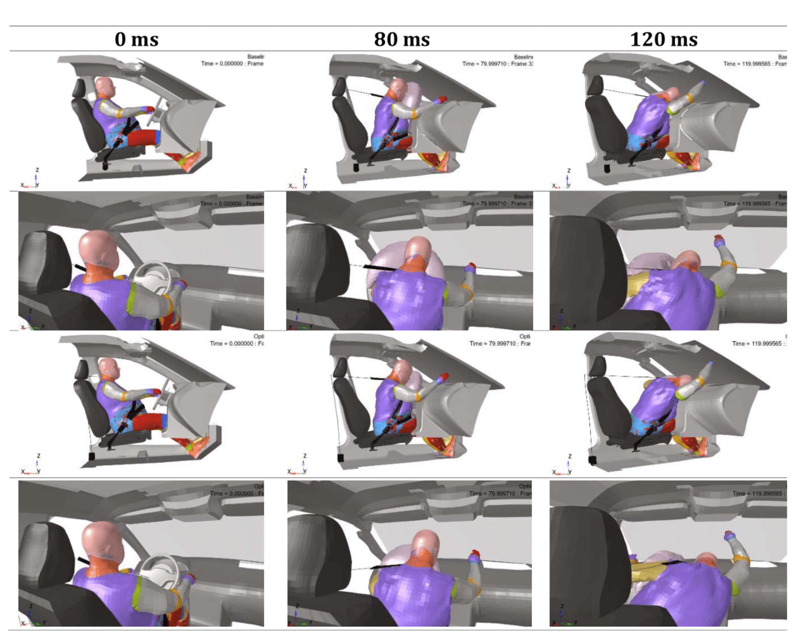
- The numerical simulation models were entirely built on **ABAQUS**.
- The finite element models were simulated using the **Explicit Dynamics** solver in the **Temperature-Displacement** domain.
- **Mass scaling** is utilized to accelerate the simulations while preserving the accuracy.

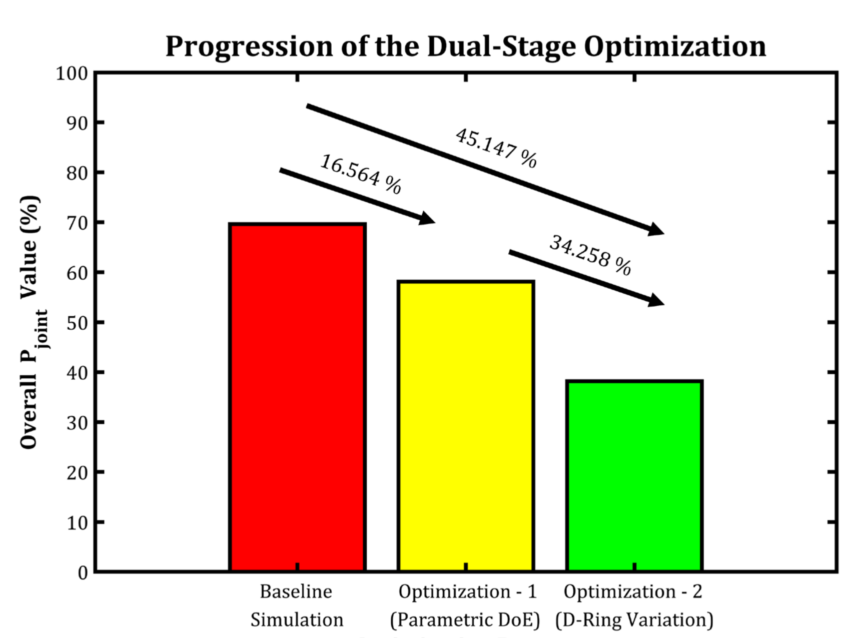
Results

- **Cutting forces** were validated with those obtained from **experimental machining** tests on a HAAS VF2-YT machine.
- **Chip morphologies** were also compared to strengthen the validity of the proposed simulation models.
- Successful study on the **influence of porosity** on the trend of cutting forces.

Design optimization for obese male driver in oblique far-side impact







Overview

- A **design optimization** to improve occupant protection for an obese aged male driver in an oblique far-side impact.
- Oblique frontal crashes are challenging to design for owing to limited regulation tests and research.

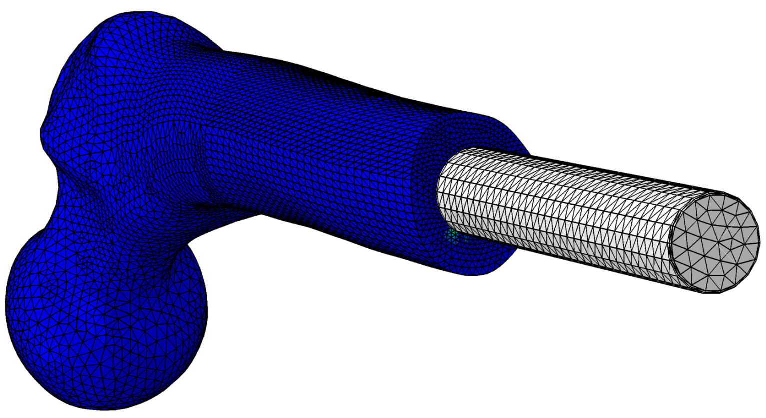
Approach

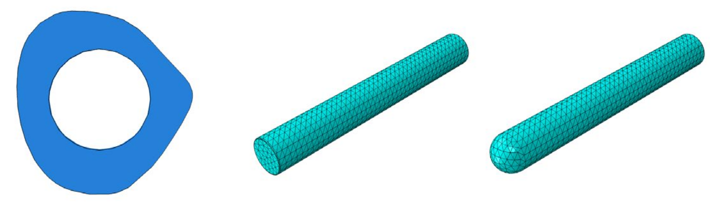
- Utilized **LS-PrePost** for model set-up and **LS-Dyna** for running the simulations.
- Implemented a dual stage optimization process involving a parametric study using **Taguchi method** followed by D-Ring position variation.

Results

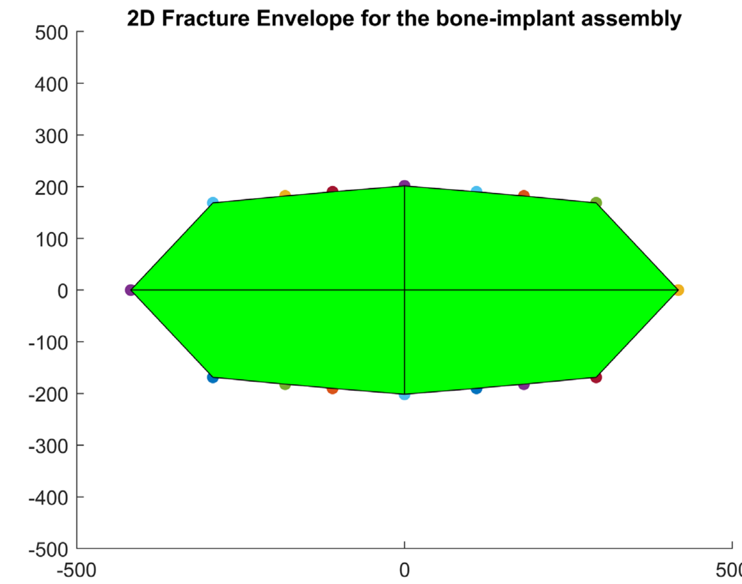
- A total of **27 crash simulations** were run and the joint injury values were investigated .
- Achieved a **45% optimization** by improving the overall occupant kinematics and reducing chest and brain injury risks.

Finite element analysis of bone-fixture joint in osseointegration





Load \ Implant	Filleted	Rounded
50N (+Y)	80.3 MPa	57.6 MPa
50N (-Y)	100.2 MPa	51.08 MPa
50N (+Z)	77.86 MPa	32.71 MPa
50N (-Z)	36.77 MPa	39.54 MPa



Overview

- A **Finite element model** to model the bone-fixture joint in osseointegration.
- To study the effect of various loads on the joint with the objective of deriving the **optimal fracture envelope**.
- Anisotropic material properties for human femur were chosen to make the simulations realistic.

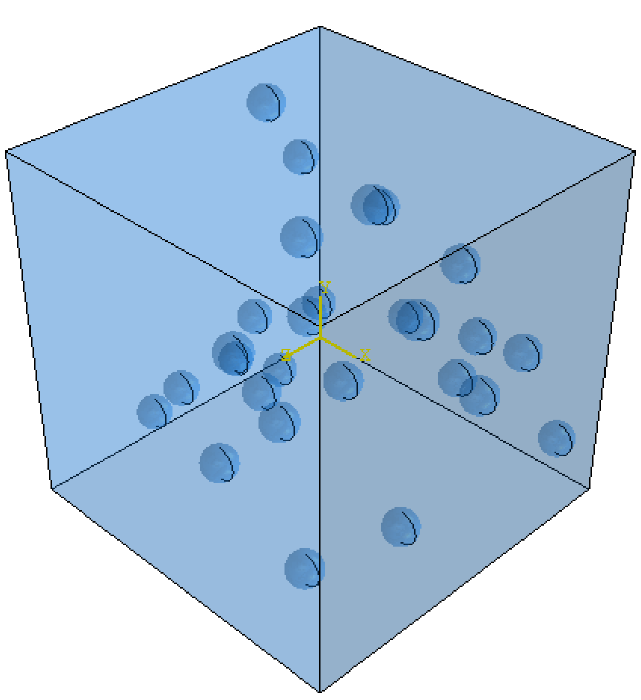
Approach

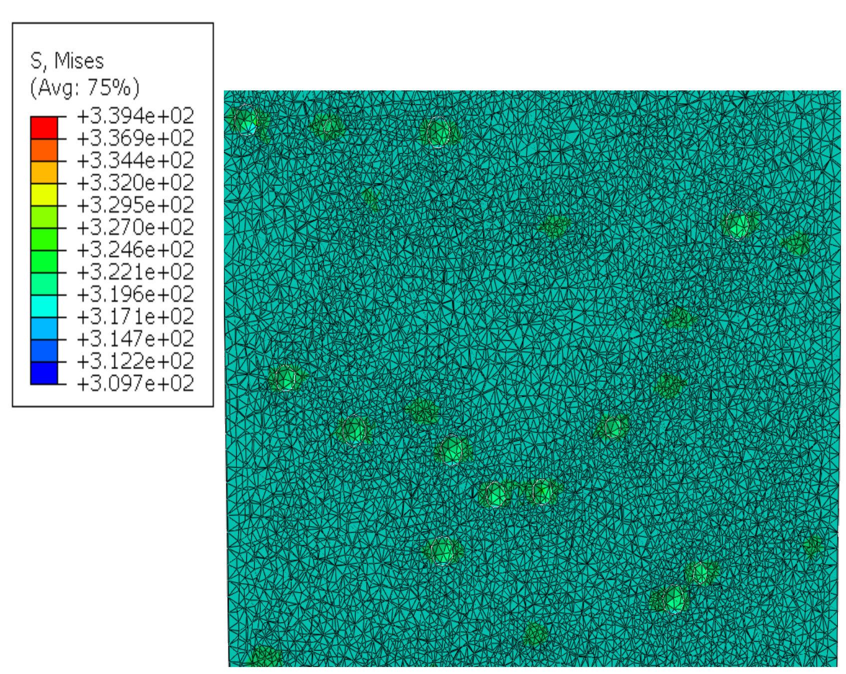
- The entire assembly of components was modelled on **ABAQUS**.
- The effect of two different implants on stress distribution was studied involving filleted and rounded ends.
- The fracture envelope was obtained by post-processing the numerical simulation results using **MATLAB**.

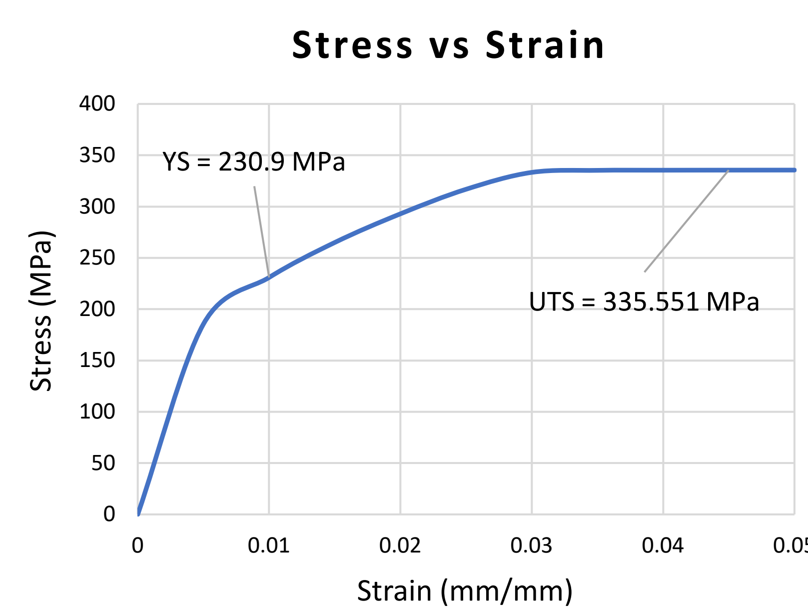
Results

- Python scripting algorithmic modules were developed and integrated into ABAQUS to automate the assembly process and run simultaneous simulations.
- Derived an optimal fracture envelope for the joint upon analyzing transverse stresses and reaction forces from simulating 16 load cases.

Finite element modeling of microstructural porosity







Overview

- A **Finite Element Model** to model microstructural porosity as induced defects of additively manufactured AlSi10Mg parts.
- To study its effect on the mechanical properties like yield strength and ultimate tensile strength.
- Mathematical model to reduce dependency on practical tests.

Approach

- **Python scripting** coupled with **ABAQUS** to integrate computer programming with finite element analysis.
- Developed an algorithm to automate the modelling of porosity with user-defined variables.
- Random pores with non-uniform size and distribution using iterative approach.

Results

- The numerical model was validated with experimental data obtained from literature.
- The simulation results reported yield strength and ultimate tensile strength of 230.9 MPa and 335.551 MPa indicating **99.84% accuracy**.
- Pathway for machine-learning to eliminate experimental tests was envisioned.